EBL2: A New EUV Exposure and Analysis Facility

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Summary

The introduction of ever higher source powers in EUV systems causes increased risks for contamination and degradation of EUV optics, sensors, masks and pellicles. One of the least understood degradation mechanisms is the effect of EUV-induced plasmas generated by photo-ionization of background gas. Appropriate testing can help to inventory and mitigate these risks. To this end, we are preparing to build EBL2: a laboratory EUV exposure system capable of operating at high EUV powers and intensities.

Current facility

The proposed system architecture is similar to the EBL facility which has been operated jointly by TNO and Carl Zeiss SMT since 2005. The facility contains an EUV Beam Line, in which samples can be exposed to EUV irradiation in a controlled environment. Attached to beam line is an XPS system, which can be reached via an in-vacuum sample transfer system. This enables surface analysis of exposed samples without breaking vacuum. The compound instrument is used to develop and validate optics lifetime strategies for ASML EUV scanners[1].

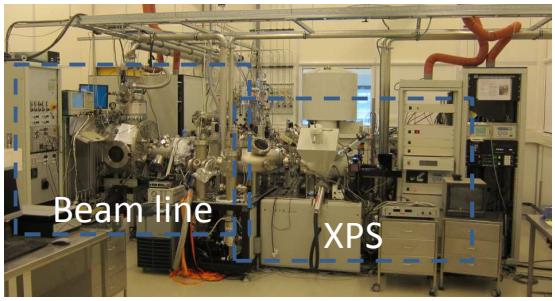

Figure 1: EBL facility at TNO

EBL2 improvements

EUV-induced plasmas can be observed in the current Beam Line at elevated operating pressures, as shown in Figure 2. However, to study the effect of EUV-induced plasmas under realistic conditions, an improved facility is needed. Targeted improvements include:

- Increased EUV power and intensity
- Increased flexibility:
    - Samples up to EUV mask size (152 mm square)
    - Tunable EUV spot size & profile
    - More spectral filtering options
- Increased reliability through automated sample handling, better source automation, and improved dose control
- Increased sample data:
    - In-situ ellipsometry during exposure
    - Additional ports for EUVR or other analysis tools.
- XPS capable of analyzing full 6” reticles

EBL2 will be placed in a conditioned area to maintain compatibility with fabs and mask houses and enable shipping of clean reticles.

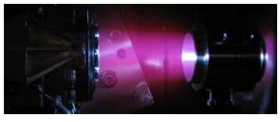

Figure 2: EUV induced plasma at elevated operating gas pressure

EBL2 architecture

The facility will be centered around a sample handling system based on ADT reticle handling equipment, with ports connecting to the various functional units. These will include a load lock and pod opener for loading masks and samples from dual pods, a flipping and cleaning unit, an XPS capable of analyzing EUV masks, and a beam line that can expose them to EUV and EUV-induced plasmas.
The beam line will consist of Xe-fueled EUV source, a grazing incidence collector with differential pumping, and an exposure chamber. The exposure chamber can mimic a range of gas conditions relevant to EUV induced plasmas. It can be modified with the addition of custom EUV optics, probes, etc., to provide maximum experimental flexibility. An additional port allows to add EUVR functionality without exposing the sample to air.

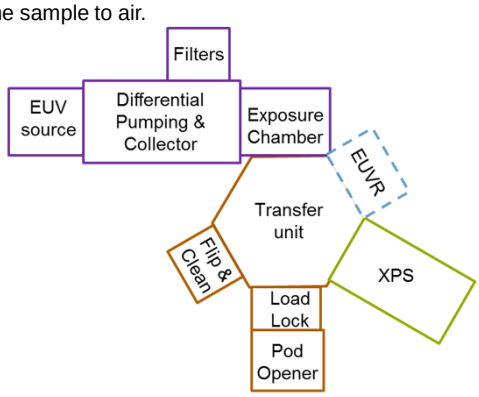

Figure 3: EBL2 architecture overview

Status and outlook

The architecture has been baselined and detailed design is currently in progress. EBL2 is planned to become operational early 2016. In addition to enabling further research into EUV-induced plasmas, EBL2 will be offered as an independent research facility service, offering both EUV exposures and XPS analyses on samples and full reticles. In combination with its other facilities ICCC can address optics life time, contamination control, plasma physics, material, pellicle and cleaning research questions.

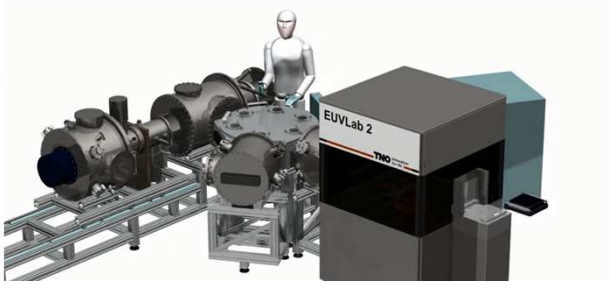

Figure 4: CAD impression of EBL2

Acknowledgements

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1. N. Harned et al., EUVL symposium 2008, Lake Tahoe